STAFF PAPER FOR DISCUSSION

at the December 12 Workshop on Proposed Amendments to the Energy Efficiency Standards

Fenestration Issues

Staff recommends that when reviewing the proposed amendments you may want to follow along with a complete copy of the *Energy Efficiency Standards*. This helps to both discern the context of the change and spot other possible changes which could provide more clarification.

Certification and Labelling

Issue #1

Require all manufactured fenestration products to be labelled with a U-value, thus eliminating the current option to assume a site-built default if there is no label on the product. The labelled U-value can either be a tested U-value or a CEC default U-value.

Proposed Amendment

Section 10-111. Certification and Labeling of Fenestration Product U-Values.

. . .

(a) Labeling Requirements.

(1) **Temporary Labels.** Every manufactured fenestration product installed in new construction subject to the California Energy Code shall have attached to it a clearly visible temporary label that lists the U-value of that product and the method used to derive the U-value.

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Section 116: Mandatory Requirements for Exterior Doors, Windows, and Fenestration Products.

. . .

(b) Installation of Site Constructed Doors, Skylights, and Windows. ~~Site constructed doors, skylights, and windows, including, but not limited to, f~~Field manufactured doors, skylights, and windows, shall be caulked between the door, skylights, or window and the building, and shall be weatherstripped.

EXCEPTION to Section 116(b): Unframed glass doors and fire doors.

Issue #2

The air leakage rate for manufactured fenestration products needs to be updated for consis-

tency with national requirements.

Proposed Amendment

Section 116: Mandatory Requirements for Exterior Doors, Windows, and Fenestration Products.

(a) Certification of Manufactured Exterior Doors and Windows and Manufactured Fenestration Products. . .

1. Manufactured Doors and Windows. Manufactured doors and windows shall have air infiltration rates not exceeding those shown in Table No. 1-~~E~~ED, when tested according to ASTM E283-91 at a pressure differential of 75 pascals or 1.57 pounds/ft2.

TABLE NO. 1-~~E~~ED
MAXIMUM AIR INFILTRATION RATES

	WINDOWS (cfm/ft2 of ~~operable sash crack~~window area)	**RESIDENTIAL DOORS** (cfm/ft2 of door area)	**ALL OTHER DOORS** (cfm/ft2 of door area)	
Type	all	swinging, sliding	sliding, swinging (single door)	swinging (double door)
Rate	0.3~~7~~	0.3~~7~~	0.3~~7~~	1.0

Labeled SHGC vs. SC

Issue #3

The National Fenestration Rating Council (NFRC) is testing and labeling the solar heat gain coefficient (SHGC), which will be a tremendous benefit to building inspectors who have had no simple way to verify the solar properties of fenestration products. Although labeling for SHGC is not mandatory in the NFRC process, by including a provision for this labeled value in the *Energy Efficiency Standards* it may become more prevalent.

There must also be a table of default values for fenestration products without a labelled SHGC, and a method for converting SC to SHGC, as well as a provision for alternative testing. The tables and conversion method will be provided in the compliance manuals.

Proposed Amendment

Section 10-111. Certification and Labeling of Fenestration Product U-Values.

. . .

(a) Labeling Requirements.

(1) **Temporary Labels.** Every fenestration product installed in new construction subject to the California Energy Code shall have attached to it a clearly visible temporary label that lists the U-value of that product and the method used to derive the U-value.

(A) If the product rating is taken from the Commission's default table, placing the words "CEC Default U-value," followed by the appropriate default U-value, on the temporary label meets the requirement of paragraph 1.

(B) If the product rating is derived from the NFRC Rating Procedure, placing the words "Manufacturer stipulates that this rating was determined in accordance with NFRC 100-91" followed by the certified U-value on the temporary label meets the requirement of paragraph 1.

The "NFRC Rating Procedure" means the National Fenestration Rating Council's NFRC 100-91: Procedure for Determining Fenes-tration Product Thermal Properties (currently limited to U-values) June 28, 1991, also known as "NFRC 100-91".

(C) The temporary label shall also certify that the product complies with section 116(a)1 of the standards.

(D) If the product's solar heat gain coefficient (SHGC) is derived from the NFRC rating procedure, the SHGC shall appear on the temporary label.

EXCEPTION TO 10-111(a)(1)(D): Products not tested and labeled for SHGC shall determine an SHGC by one of the following methods:

1. A Commission table of default SHGC values,
2. Converting an SC, determined from a test method based on ASHRAE 73-74 or ASTM E424, to an SHGC using a method set forth by the Commission, or

3. Converting an SC based on a Commission default table to an SHGC using a method set forth by the Commission.

. . .

Section 101. Definitions and Rules of Construction.

(b) Definitions. . . .

SHADING COEFFICIENT (SC) is the ratio of the solar heat gain through a fenestration product to the solar heat gain through an unshaded 1/8 inch thick clear double strength glass under the same set of conditions. For nonresidential, high-rise residential, and hotel/motel buildings, this shall exclude the effects of mullions, frames, sashes, and interior and exterior shading devices. Product shading coefficient values shall be determined either by testing to ASHRAE 74-73 or ASTM E424 test methods or using a value from the default table approved by the Commission.

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Section 116: Mandatory Requirements for Exterior Doors, Windows, and Fenestration Products.

(a) Certification of Manufactured Exterior Doors and Windows and Manufactured Fenestration Products. . .

1. Manufactured Doors and Windows. Manufactured doors and windows shall have air infiltration rates not exceeding . . .

. . .

2. Manufactured Fenestration Products. Manufactured fenestration products shall:

A. Be certified as to their overall U-values as rated in accordance with the National Fenestration Rating Council's NFRC-100-91 (June 28, 1991). . .

B. Have a temporary label, not to be removed before inspection by the enforcement agency, listing the certified U-value and certifying that the requirements of Sections 116(a)1. and 10-111(a)(1) are met; and

C. Have a permanent label . . .

Default U-value Tables
Issue #4

The default tables provided for manufactured and site-built fenestration products need to be reexamined. Section 10-112(b) requires the Commission to periodically review and revise the default U-values. This review is to ensure that the default values are set at a level where a significant number of products won't achieve a lower U-value than if they had been tested and rated.

Fenestration products that are field constructed are provided with a "Site-Built Default U-value" table. Some of the values in the site-built default table result in a lower U-value than for similar manufactured products (dual pane, non-metal frame product), which seems anomalous. The values in both the manufactured fenestration product and site-built default tables should be updated to be representative of products on the market today.

The National Fenestration Rating Council provided information on the highest U-values in their database for windows in the categories of California's default tables. The following table provides a comparison of these worst performing products and the current manufactured product and site built default values.

Double Pane Products

Frame Type	Window Type	Site-Built Default U-value	CEC Default U-value	NFRC Highest U-value	# @ or Above CEC Default	Total # of Products	% less efficient than default
Metal, No	Operable	0.93	0.87	0.94	34	712	4.78
Thermal	Fixed	0.72	0.72	0.81	23	471	5.52
Break	Door	--	0.77	0.85	18	155	11.61[1]
Metal, with	Operable	--	0.71	0.77	30	1014	2.96
Thermal	Fixed	--	0.60	0.68	26	134	19.4[2]
Break	Door	--	0.68	0.64	0	45	0
Wood or	Operable	0.55	0.60	0.67	11	2152	0.51
Vinyl,	Fixed	0.57	0.57	0.67	17	1008	1.69
non-Metal	Door	--	0.55	0.57	19	410	4.63

Single Pane Products

Frame Type	Window Type	Site-Built Default U-value	CEC Default U-value	NFRC Highest U-value	# @ or Above CEC Default	Total # of Products	% less efficient than default
Metal, No	Operable	1.32	1.28	--	0	0	0
Thermal	Fixed	1.19	1.19	1.18	0	2	0
Break	Door	--	1.25	--	0	0	0
Wood or	Operable	0.99	0.92	1.05	25	98	25.51[3]
Vinyl,	Fixed	1.04	1.04	1.05	8	105	7.62
non-Metal	Door		0.99	1.05	2	68	2.94

After examining these values, staff's has identified the following activities:

1. Change the site built values.

2. Evaluate those product categories where the current default values result in more than 2 percent of tested products receiving a lower U-value than the current default U-value. We assume that manufacturers generally tend to provide better performing products for NFRC certification than the average products available. A manufacturer with a product which does not perform well gains little, if any, competitive advantage from the expenditures necessary to have their products certified. Therefore, the average performance of non-certified products should be significantly worse than the performance of certified fenestration options. By choosing to reconsider U-values where over 2 percent of certified products fall below the value, we insure that manufacturers do not gain marketing advantage, and the public does not pay higher energy bills, through the manufacturer using default U-values.

3. Examine product categories in which the highest U-value is greater than 10 percent higher than the CEC default U-value and possibly raise the default U-value. These products are:

Product Description	Default U-value	Highest U-value
Metal Frame, Fixed, Double-Glazed	0.72	0.81
Metal Frame, Door, Double-Glazed	0.77	0.85
Metal Frame, Thermally Broken, Fixed, Double-Glazed	0.72	0.81
Wood/Vinyl, Operable, Double-Glazed	0.60	0.67
Wood/Vinyl, Fixed, Double Glazed	0.57	0.67

A more thorough review of the NFRC data is included in the attached table "Fenestration Products Data."

Proposed Change

Section 10-111. Certification and Labeling of Fenestration Product U-Values.

. . .

(a) Labeling Requirements.

(1) **Temporary Labels.** . .

(A) If the product rating is taken from the Commission's default table, placing the words "CEC Default U-value," followed by the appropriate default U-value from Section 116, Table No. 1E, on the temporary label meets the requirement of paragraph 1.

. . .

(b) Certification Requirements.

(1) **Certification to Default U-Values**. If a product's U-value is taken from the Commission's default table (Section 116, Table No. 1-E), the U-value shall be certified by either the manufacturer or an independent certifying organization approved by the Commission.

. . .

Section 116: Mandatory Requirements for Exterior Doors, Windows, and Fenestration Products.

(a) Certification of Manufactured Exterior Doors and Windows and Manufactured Fenestration Products. Any manufactured doors or windows or manufactured fenestration product may be installed only if the manufacturer has certified to the Commission, or if an independent certifying organization approved by the Commission has certified, that the product complies with all of the applicable requirements of this subsection.

. . .

2. Manufactured Fenestration Products. Manufactured fenestration products shall:

A. Be certified as to their overall U-values as rated in accordance with the National Fenestration Rating Council's NFRC-100-91 (June 28, 1991), incorporated herein by reference or in accordance with a default table method as set forth in Section 10-111 ~~approved by the Commission~~; and

. . .

Table No. 1-E
Default Fenestration Products

		Single Pane		Double Pane[2]	
Frame Type[1]	**Window Type**	**Site Built U-value**	**Manufac-tured Product U-value**	**Site Built U-value**	**Manufac-tured Product U-value**
Metal, Non-thermal Break	Operable	1.32	1.28	0.93	0.90
Metal, Non-thermal Break	Fixed	1.19	1.19	0.72	0.77
Metal, Non-thermal Break	Door	--	1.25		0.81
Metal, Non-thermal Break	Skylights		1.26		0.80
Metal, Non-thermal Break	Greenhouse		1.26		1.40
Metal, Thermal Break	Operable				0.74
Metal, Thermal Break	Fixed				0.63
Metal, Thermal Break	Door				0.64
Metal, Thermal Break	Skylights				0.70
Metal, Thermal Break	Greenhouse				1.12
Non-Metal	Operable	0.99	1.04	0.60	0.60
Non-Metal	Fixed	1.04	1.04	0.57	0.57
Non-Metal	Door		0.99		0.57
Non-Metal	Skylights		0.91		0.55
Non-Metal	Greenhouse		1.94		1.06

[1] Metal includes any site built product with metal cladding. Non-metal framed manufactured products with metal cladding must add 0.04 to the listed U-value. Non-Metal frame types can include metal fasteners, hardware, and door thresholds. Thermal break product design characteristics are:

a. The material used as the thermal break must have a thermal conductivity of not more than 3.6 Btu-inch/hr/ft^2/˚F, and;
b. The thermal break must produce a gap of not less than 0.210", and;
c. All metal members of the product exposed to interior and exterior air must incorporate a thermal break meeting the criteria in (a) and (b) above.

In addition, the product must be clearly labeled by the manufacturer that it qualifies as a thermally broken product in accordance with this standard.

[2]For all dual glazed fenestration products, adjust the listed U-values as follows:

a. Subtract 0.05 for spacers of 7/16" or wider.
b. Subtract 0.05 for Low-E glazing.
c. Add 0.05 for products with dividers between panes if spacer is less than 7/16" wide.
d. Add 0.0 to any product with true divided lite (dividers through the panes).

Miscellaneous Changes
Issue #5

This portion deals with miscellaneous language directly or indirectly associated with shading and glazing that need to be updated or corrected. Included in the proposed amendments are inconsistent definitions ("well factor" is called "well index" in the nonresidential manual and well index appears to be the correct term). References to Shading Coefficient (SC) are updated to refer to Solar Heat Gain Coefficient (SHGC). Staff verified that load calculation methods allow the use of either SC or SHGC. Staff is also recommending that the residential outdoor design conditions be updated to match the language for nonresidential design conditions.

Proposed Amendments

Section 101. Definitions and Rules of Construction.

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(b) Definitions. . .

EFFECTIVE APERTURE (EA) is (1) for windows, the visible light transmittance (VLT) times the window wall ratio; and (2) for skylights, the well ~~factor~~ index times the VLT times the skylight area times 0.85 divided by the gross exterior roof area.

. . .

SOLAR HEAT GAIN COEFFICIENT (SHGC) is the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

[NOTE to reviewers: This definition is from ASHRAE which is from NFRC 200-95.]

. . .

WELL ~~FACTOR~~ INDEX is the ratio of the amount of visible light leaving a skylight well to the amount of visible light entering the skylight well and is calculated as follows:

(a) for rectangular wells:

$$\left(\frac{\text{Wellheight}(\text{welllength} + \text{wellwidth})}{2\ \text{X welllength X wellwidth}}\right)$$

; or

(b) for irregular shaped wells:

$$\left(\frac{\text{WellheightXwellperimeter}}{4\text{Xwellarea}}\right)$$

Where the length, width, perimeter, and area are measured at the bottom of the well, and R is the weighted average reflectance of the walls of the well.

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Section 141. Performance Approach: Energy Budgets.

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(c) Calculation of Budget and Energy Use. When calculating the energy budget under subsection (a) and the source energy use under subsection (b), all of the following rules shall apply:

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5. ~~Shading~~ Solar Heat Gain Coefficients. ~~Shading~~ Solar heat gain coefficients shall be determined using the values listed in ASHRAE Handbook, 1989, Fundamentals Volume, Chapter 27 or a method approved by the Commission, and shall not be adjusted for the effects of framing and interior or exterior shading devices.

Section 143. Prescriptive Requirements For Building Envelopes.

. . .

(a) Envelope Component Approach.

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5. Windows. Windows shall:

. . .

C. Have a relative solar heat gain, excluding the effects of interior shading, no greater than the applicable value in Table No. 1-I or 1-J. The relative solar heat gain of windows is:

i. The ~~shading~~ solar heat gain coefficient of the windows; or
ii. Relative Solar Heat Gain as calculated by Equation No. 1-B, if an overhang extends beyond both sides of the window jamb a distance equal to the overhang projection.

. . .

EQUATION NO. 1-B
RELATIVE SOLAR HEAT GAIN EQUATION

$$RSHG = SHGC_{win} \times [\, 1 + aH/V + b(H/V)^2 \,]$$

Where:

RSHG = Relative solar heat gain.
SC_{win} = ~~Shading~~Solar heat gain coefficient of the window.
H = Horizontal projection of the overhang from the surface of the window in feet, but no greater than V.
V = Vertical distance from the window sill to the bottom of the overhang, in feet.
a = -0.41 for North-facing windows, -1.22 for South-facing windows, and -0.92 for East- and West-facing windows.
b = 0.20 for North-facing windows, 0.66 for South-facing windows, and 0.35 for East- and West-facing windows.

6. Skylights. Skylights shall:

. . .

C. Have a ~~shading~~ solar heat gain coefficient no greater than the applicable value in Table No. 1-I or 1-J.

Section 144. Prescriptive Requirements For Space Conditioning Systems.

(b) Calculations. In making equipment sizing calculations under subsection (a), all of the following rules shall apply:

. . .

6. Envelope. Envelope heating and cooling loads shall be calculated using envelope characteristics including square footage, thermal conductance, solar heat gain coefficient or shading coefficient, and air leakage, consistent with the proposed design.

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Section 150. Mandatory Features and Devices

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(h) Space Conditioning Equipment.

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2. Design Conditions.

For the purpose of sizing the space conditioning (HVAC) system, the indoor design temperatures shall be 70 degrees Fahrenheit for heating and 78 degrees for cooling. The outdoor design temperatures for heating shall be no lower

than ~~those listed in~~ the ~~0.2 percent~~ Winter ~~Dry Bulb~~ Median of Extremes column ~~for heating and~~. The outdoor design temperatures for cooling shall be from the 0.5 percent Summer Design Dry Bulb and the 0.5 percent Wet Bulb columns for cooling, based on percent-of-year in ASHRAE publication *SP~~P~~CDX: Climate Data for Region X, Arizona, California, Hawaii, and Nevada*, 1982.

1.The bottom (poorest performing) 25% of products (39) range from 0.75 to 0.85, with the five highest product U-values being 0.81, 0.81, 0.82, 0.84 and 0.85.

2. The bottom 25% of products (34) range from 0.59 to 0.68, with The five highest product U-values are 0.63, 0.66, 0.66, 0.68 and 0.68.

3.The bottom 25% of products (25) range from 0.92 to 1.05, with the five highest product U-values being 0.99, 0.99, 1.04, 1.05 and 1.05.